

CLAIMS

1. An optical amplifier apparatus comprising:
 - an optical amplifier which amplifies an input signal light;
 - 5 an output detecting unit which detects an output level of said optical amplifier;
 - an output control unit which controls an output level of said optical amplifier according to an output level detected by said output detecting unit;
 - 10 a gain inclination detecting unit which detects a gain inclination relating to a wavelength of said optical amplifier; and
 - a gain inclination control unit which controls a gain inclination of said optical amplifier according to a gain
 - 15 inclination detected by said gain inclination detecting unit.
2. The optical amplifier apparatus according to claim 1, wherein said gain inclination detecting unit branches
- 20 a wavelength-multiplexed signal light, and detects a gain inclination from optical signal levels of a shortest wave and a longest wave.

3. The optical amplifier apparatus according to claim 1, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain inclination from optical signal levels of three or more waves.

4. The optical amplifier apparatus according to claim 1, wherein said optical amplifier apparatus inputs a wavelength-multiplexed signal light having mutually different frequency components superimposed on optical signals of a shortest wave and a longest wave respectively, and said gain inclination detecting unit detects frequency components superimposed on the optical signals of respective wavelengths thereby to detect a gain inclination.

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5. The optical amplifier apparatus according to claim 1, wherein said optical amplifier apparatus inputs a wavelength-multiplexed signal light having mutually different frequency components superimposed on optical signals of three or more waves respectively, and said gain inclination detecting unit detects frequency components superimposed on the optical signals thereby to detect a gain inclination.

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6. An optical amplifier apparatus comprising:
an optical amplifier which amplifies an input
wavelength-multiplexed signal light;
an optical variable attenuator which attenuates an
5 output signal light of said optical amplifier;
an output detecting unit which detects an output level
at an output side of said optical variable attenuator;
an output control unit which controls the attenuation
of an output signal light attenuated by said optical variable
10 attenuator according to an output level detected by said
output detecting unit;
a gain inclination detecting unit which detects a gain
inclination relating to a wavelength of said optical
amplifier; and
15 a gain inclination control unit which controls a gain
inclination by adjusting an output light of an excitation
light source of said optical amplifier according to a gain
inclination detected by said gain inclination detecting
unit.
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7. The optical amplifier apparatus according to claim
6, wherein said gain inclination detecting unit branches
a wavelength-multiplexed signal light, and detects a gain
inclination from optical signal levels of a shortest wave
25 and a longest wave.

8. The optical amplifier apparatus according to claim
6, wherein said gain inclination detecting unit branches
a wavelength-multiplexed signal light, and detects a gain
inclination from optical signal levels of three or more
5 waves.

9. The optical amplifier apparatus according to claim
6, wherein said optical amplifier apparatus inputs a
wavelength-multiplexed signal light having mutually
10 different frequency components superimposed on optical
signals of a shortest wave and a longest wave respectively,
and said gain inclination detecting unit detects frequency
components superimposed on the optical signals of respective
wavelengths thereby to detect a gain inclination.

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10. The optical amplifier apparatus according to claim
6, wherein said optical amplifier apparatus inputs a
wavelength-multiplexed signal light having mutually
different frequency components superimposed on optical
20 signals of three or more waves respectively, and said gain
inclination detecting unit detects frequency components
superimposed on the optical signals thereby to detect a gain
inclination.

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11. An optical amplifier apparatus comprising:

an optical amplifier which amplifies an input wavelength-multiplexed signal light;

an optical variable attenuator which attenuates an
5 output signal light of said optical amplifier;

an output detecting unit which detects an output level at an output side of said optical variable attenuator;

an output control unit which controls an output light of an excitation light source of said optical amplifier
10 according to an output level detected by said output detecting unit;

a gain inclination detecting unit which detects a gain inclination relating to a wavelength of said optical amplifier; and

15 a gain inclination control unit which controls a gain inclination by adjusting the attenuation of an output signal light attenuated by said optical variable attenuator according to a gain inclination detected by said gain inclination detecting unit.

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12. The optical amplifier apparatus according to claim 11, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain inclination from optical signal levels of a shortest wave
25 and a longest wave.

13. The optical amplifier apparatus according to claim 11, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain inclination from optical signal levels of three or more waves.

14. The optical amplifier apparatus according to claim 11, wherein said optical amplifier apparatus inputs a wavelength-multiplexed signal light having mutually different frequency components superimposed on optical signals of a shortest wave and a longest wave respectively, and said gain inclination detecting unit detects frequency components superimposed on the optical signals of respective wavelengths thereby to detect a gain inclination.

15. The optical amplifier apparatus according to claim 11, wherein said optical amplifier apparatus inputs a wavelength-multiplexed signal light having mutually different frequency components superimposed on optical signals of three or more waves respectively, and said gain inclination detecting unit detects frequency components superimposed on the optical signals thereby to detect a gain inclination.

16. An optical amplifier apparatus comprising:

an optical amplifier which amplifies an input wavelength-multiplexed signal light;

a compensation light source which injects a
5 compensation light that propagates in a forward direction
of a propagation direction of an input signal light to said
optical amplifier;

a wavelength selecting unit which interrupts a
compensation light at an output side of said optical
10 amplifier, and transmits only a signal light;

an output detecting unit which detects an output level
of a signal light at an output side of said wavelength
selecting unit;

an output control unit which controls an output light
15 of said compensation light source according to an output
level detected by said output detecting unit;

a gain inclination detecting unit which detects a gain
inclination of said optical amplifier; and

a gain inclination control unit which controls a gain
20 inclination by adjusting an output light of an excitation
light source of said optical amplifier according to a gain
inclination detected by said gain inclination detecting
unit.

17. The optical amplifier apparatus according to claim 16, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain inclination from optical signal levels of a shortest wave
5 and a longest wave.

18. The optical amplifier apparatus according to claim 16, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain
10 inclination from optical signal levels of three or more waves.

19. The optical amplifier apparatus according to claim 16, wherein said optical amplifier apparatus inputs a
15 wavelength-multiplexed signal light having mutually different frequency components superimposed on optical signals of a shortest wave and a longest wave respectively, and said gain inclination detecting unit detects frequency components superimposed on the optical signals of respective
20 wavelengths thereby to detect a gain inclination.

20. The optical amplifier apparatus according to claim 16, wherein said optical amplifier apparatus inputs a
wavelength-multiplexed signal light having mutually
25 different frequency components superimposed on optical

signals of three or more waves respectively, and said gain inclination detecting unit detects frequency components superimposed on the optical signals thereby to detect a gain inclination.

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21. An optical amplifier apparatus comprising:

an optical amplifier which amplifies an input wavelength-multiplexed signal light;

a compensation light source which injects a
10 compensation light that propagates in a forward direction of a propagation direction of the input signal light to said optical amplifier;

a wavelength selecting unit which interrupts a compensation light at an output side of said optical
15 amplifier, and transmits only a signal light;

an output detecting unit which detects an output level of a signal light at an output side of said wavelength selecting unit;

an output control unit which controls an output light
20 of an excitation light source of said optical amplifier according to an output level detected by said output detecting unit;

a gain inclination detecting unit which detects a gain inclination of said optical amplifier; and

25 a gain inclination control unit which controls a gain

inclination by adjusting an output light of said compensation light source according to a gain inclination detected by said gain inclination detecting unit.

5 22. The optical amplifier apparatus according to claim 21, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain inclination from optical signal levels of a shortest wave and a longest wave.

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23. The optical amplifier apparatus according to claim 21, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain inclination from optical signal levels of three or more
15 waves.

24. The optical amplifier apparatus according to claim 21, wherein said optical amplifier apparatus inputs a wavelength-multiplexed signal light having mutually
20 different frequency components superimposed on optical signals of a shortest wave and a longest wave respectively, and said gain inclination detecting unit detects frequency components superimposed on the optical signals of respective wavelengths thereby to detect a gain inclination.

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25. The optical amplifier apparatus according to claim 21, wherein said optical amplifier apparatus inputs a wavelength-multiplexed signal light having mutually different frequency components superimposed on optical signals of three or more waves respectively, and said gain inclination detecting unit detects frequency components superimposed on the optical signals thereby to detect a gain inclination.
- 10 26. An optical amplifier apparatus comprising:
- an optical amplifier which amplifies an input wavelength-multiplexed signal light;
 - a compensation light source which injects a compensation light that propagates in a forward direction of a propagation direction of the input signal light to said optical amplifier;
 - an optical variable attenuator which attenuates an output signal light of said optical amplifier;
 - a wavelength selecting unit which interrupts a compensation light at an output side of said optical variable attenuator, and transmits only a signal light;
 - an output detecting unit which detects an output level of a signal light at an output side of said wavelength selecting unit;
 - 25 an output control unit which controls the attenuation

of an output signal light of said optical variable attenuator according to an output level detected by said output detecting unit;

a gain inclination detecting unit which detects a gain
5 inclination of said optical amplifier; and

a gain inclination control unit which controls a gain inclination by adjusting an output light of said compensation light source according to a gain inclination detected by said gain inclination detecting unit.

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27. The optical amplifier apparatus according to claim 26, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain inclination from optical signal levels of a shortest wave
15 and a longest wave.

28. The optical amplifier apparatus according to claim 26, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain
20 inclination from optical signal levels of three or more waves.

29. The optical amplifier apparatus according to claim 26, wherein said optical amplifier apparatus inputs a
25 wavelength-multiplexed signal light having mutually

different frequency components superimposed on optical signals of a shortest wave and a longest wave respectively, and said gain inclination detecting unit detects frequency components superimposed on the optical signals of respective
5 wavelengths thereby to detect a gain inclination.

30. The optical amplifier apparatus according to claim 26, wherein said optical amplifier apparatus inputs a wavelength-multiplexed signal light having mutually
10 different frequency components superimposed on optical signals of three or more waves respectively, and said gain inclination detecting unit detects frequency components superimposed on the optical signals thereby to detect a gain inclination.

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31. An optical amplifier apparatus comprising:
an optical amplifier which amplifies an input wavelength-multiplexed signal light;
a compensation light source which injects a
20 compensation light that propagates in a forward direction of a propagation direction of the input signal light to said optical amplifier;
an optical variable attenuator which attenuates an output signal light of said optical amplifier;
25 a wavelength selecting unit which interrupts a

compensation light at an output side of said optical variable attenuator, and transmits only a signal light;

an output detecting unit which detects an output level of a signal light at an output side of said wavelength
5 selecting unit;

an output control unit which controls an output light of said compensation light source according to an output level detected by said output detecting unit;

a gain inclination detecting unit which detects a gain
10 inclination of said optical amplifier; and

a gain inclination control unit which controls a gain inclination by adjusting the attenuation of an output signal light attenuated by said optical variable attenuator according to a gain inclination detected by said gain
15 inclination detecting unit.

32. The optical amplifier apparatus according to claim 31, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain
20 inclination from optical signal levels of a shortest wave and a longest wave.

33. The optical amplifier apparatus according to claim 31, wherein said gain inclination detecting unit branches
25 a wavelength-multiplexed signal light, and detects a gain

inclination from optical signal levels of three or more waves.

34. The optical amplifier apparatus according to claim
5 31, wherein said optical amplifier apparatus inputs a
wavelength-multiplexed signal light having mutually
different frequency components superimposed on optical
signals of a shortest wave and a longest wave respectively,
and said gain inclination detecting unit detects frequency
10 components superimposed on the optical signals of respective
wavelengths thereby to detect a gain inclination.

35. The optical amplifier apparatus according to claim
31, wherein said optical amplifier apparatus inputs a
15 wavelength-multiplexed signal light having mutually
different frequency components superimposed on optical
signals of three or more waves respectively, and said gain
inclination detecting unit detects frequency components
superimposed on the optical signals thereby to detect a gain
20 inclination.

36. An optical amplifier apparatus comprising:
a first optical amplifier which amplifies an input
wavelength-multiplexed signal light;
25 an optical variable attenuator which attenuates an

output signal light of said first optical amplifier;
a second optical amplifier which amplifies an output
signal light of said optical variable attenuator;
an output detecting unit which detects an output level
5 at an output side of said second optical amplifier;
an output control unit which controls the attenuation
of an output signal light attenuated by said optical variable
attenuator according to an output level detected by said
output detecting unit;
10 a gain inclination detecting unit which detects a gain
inclination of said second optical amplifier; and
a gain inclination control unit which controls a gain
inclination by adjusting output lights of excitation light
sources of said first optical amplifier and said second
15 optical amplifier according to a gain inclination detected
by said gain inclination detecting unit.

37. The optical amplifier apparatus according to claim
36, wherein said gain inclination detecting unit branches
20 a wavelength-multiplexed signal light, and detects a gain
inclination from optical signal levels of a shortest wave
and a longest wave.

38. The optical amplifier apparatus according to claim 36, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain inclination from optical signal levels of three or more waves.

39. The optical amplifier apparatus according to claim 36, wherein said optical amplifier apparatus inputs a wavelength-multiplexed signal light having mutually different frequency components superimposed on optical signals of a shortest wave and a longest wave respectively, and said gain inclination detecting unit detects frequency components superimposed on the optical signals of respective wavelengths thereby to detect a gain inclination.

40. The optical amplifier apparatus according to claim 36, wherein said optical amplifier apparatus inputs a wavelength-multiplexed signal light having mutually different frequency components superimposed on optical signals of three or more waves respectively, and said gain inclination detecting unit detects frequency components superimposed on the optical signals thereby to detect a gain inclination.

41. An optical amplifier apparatus comprising:
a first optical amplifier which amplifies an input wavelength-multiplexed signal light;
an optical variable attenuator which attenuates an
5 output signal light of said first optical amplifier;
a second optical amplifier which amplifies an output signal light of said optical variable attenuator;
an output detecting unit which detects an output level at an output side of said second optical amplifier;
10 an output control unit which controls output lights of excitation light sources of said first optical amplifier and said second optical amplifier according to an output level detected by said output detecting unit;
a gain inclination detecting unit which detects a gain
15 inclination of said second optical amplifier; and
a gain inclination control unit which controls a gain inclination by adjusting the attenuation of an output signal light attenuated by said optical variable attenuator according to a gain inclination detected by said gain
20 inclination detecting unit.
42. The optical amplifier apparatus according to claim 41, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain
25 inclination from optical signal levels of a shortest wave

and a longest wave.

43. The optical amplifier apparatus according to claim
41, wherein said gain inclination detecting unit branches
5 a wavelength-multiplexed signal light, and detects a gain
inclination from optical signal levels of three or more
waves.

44. The optical amplifier apparatus according to claim
10 41, wherein said optical amplifier apparatus inputs a
wavelength-multiplexed signal light having mutually
different frequency components superimposed on optical
signals of a shortest wave and a longest wave respectively,
and said gain inclination detecting unit detects frequency
15 components superimposed on the optical signals of respective
wavelengths thereby to detect a gain inclination.

45. The optical amplifier apparatus according to claim
41, wherein said optical amplifier apparatus inputs a
20 wavelength-multiplexed signal light having mutually
different frequency components superimposed on optical
signals of three or more waves respectively, and said gain
inclination detecting unit detects frequency components
superimposed on the optical signals thereby to detect a gain
25 inclination.

46. An optical amplifier apparatus comprising:

an optical amplifier which amplifies an input wavelength-multiplexed signal light;

a compensation light source which injects a
5 compensation light that propagates in a forward direction of a propagation direction of the input signal light to said optical amplifier;

a first optical amplifier which amplifies the signal light;

10 an optical variable attenuator which attenuates an output signal light of said first optical amplifier;

a second optical amplifier which amplifies an output signal light of said optical variable attenuator;

a wavelength selecting unit which interrupts a
15 compensation light at an output side of said second optical amplifier, and transmits only a signal light;

an output detecting unit which detects an output level of a signal light at an output side of said wavelength selecting unit;

20 an output control unit which controls the attenuation of an output signal light attenuated by said optical variable attenuator according to an output level detected by said output detecting unit;

a gain inclination detecting unit which detects a gain
25 inclination of said second optical amplifier; and

a gain inclination control unit which controls a gain inclination by adjusting an output light of said compensation light source according to a gain inclination detected by said gain inclination detecting unit.

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47. The optical amplifier apparatus according to claim 46, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain inclination from optical signal levels of a shortest wave and a longest wave.

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48. The optical amplifier apparatus according to claim 46, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain inclination from optical signal levels of three or more waves.

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49. The optical amplifier apparatus according to claim 46, wherein said optical amplifier apparatus inputs a wavelength-multiplexed signal light having mutually different frequency components superimposed on optical signals of a shortest wave and a longest wave respectively, and said gain inclination detecting unit detects frequency components superimposed on the optical signals of respective wavelengths thereby to detect a gain inclination.

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50. The optical amplifier apparatus according to claim 46, wherein said optical amplifier apparatus inputs a wavelength-multiplexed signal light having mutually different frequency components superimposed on optical signals of three or more waves respectively, and said gain inclination detecting unit detects frequency components superimposed on the optical signals thereby to detect a gain inclination.
- 10 51. An optical amplifier apparatus comprising:
- an optical amplifier which amplifies an input wavelength-multiplexed signal light;
 - a compensation light source which injects a compensation light that propagates in a forward direction of a propagation direction of the input signal light to said optical amplifier;
 - a first optical amplifier which amplifies the signal light;
 - an optical variable attenuator which attenuates an output signal light of said first optical amplifier;
 - a second optical amplifier which amplifies an output signal light of said optical variable attenuator;
 - a wavelength selecting unit which interrupts a compensation light at an output side of said second optical amplifier, and transmits only a signal light;

an output detecting unit which detects an output level of a signal light at an output side of said wavelength selecting unit;

an output control unit which controls an output light
5 of said compensation light source according to an output level detected by said output detecting unit;

a gain inclination detecting unit which detects a gain inclination of said second optical amplifier; and

a gain inclination control unit which controls a gain
10 inclination by adjusting the attenuation of an output signal light attenuated by said optical variable attenuator according to a gain inclination detected by said gain inclination detecting unit.

15 52. The optical amplifier apparatus according to claim 51, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain inclination from optical signal levels of a shortest wave and a longest wave.

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53. The optical amplifier apparatus according to claim 51, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain inclination from optical signal levels of three or more

25 waves.

54. The optical amplifier apparatus according to claim 51, wherein said optical amplifier apparatus inputs a wavelength-multiplexed signal light having mutually different frequency components superimposed on optical signals of a shortest wave and a longest wave respectively, and said gain inclination detecting unit detects frequency components superimposed on the optical signals of respective wavelengths thereby to detect a gain inclination.

55. The optical amplifier apparatus according to claim 51, wherein said optical amplifier apparatus inputs a wavelength-multiplexed signal light having mutually different frequency components superimposed on optical signals of three or more waves respectively, and said gain inclination detecting unit detects frequency components superimposed on the optical signals thereby to detect a gain inclination.

56. An optical amplifier apparatus comprising:
an optical amplifier which amplifies an input wavelength-multiplexed signal light;
a compensation light source which injects a compensation light that propagates in a forward direction of a propagation direction of the input signal light to said optical amplifier;

a first optical amplifier which amplifies the signal light;

a second optical amplifier which amplifies an output signal light of said first optical amplifier;

- 5 a wavelength selecting unit which interrupts a compensation light at an output side of said second optical amplifier, and transmits only a signal light;

an output detecting unit which detects an output level of a signal light at an output side of said wavelength
10 selecting unit;

an output control unit which controls output lights of excitation light sources of said first optical amplifier and said second optical amplifier according to an output level detected by said output detecting unit;

- 15 a gain inclination detecting unit which detects a gain inclination of said optical amplifier; and

a gain inclination control unit which controls a gain inclination by adjusting an output light of said compensation light source according to a gain inclination detected by
20 said gain inclination detecting unit.

57. The optical amplifier apparatus according to claim 56, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain
25 inclination from optical signal levels of a shortest wave

and a longest wave.

58. The optical amplifier apparatus according to claim
56, wherein said gain inclination detecting unit branches
5 a wavelength-multiplexed signal light, and detects a gain
inclination from optical signal levels of three or more
waves.

59. The optical amplifier apparatus according to claim
10 56, wherein said optical amplifier apparatus inputs a
wavelength-multiplexed signal light having mutually
different frequency components superimposed on optical
signals of a shortest wave and a longest wave respectively,
and said gain inclination detecting unit detects frequency
15 components superimposed on the optical signals of respective
wavelengths thereby to detect a gain inclination.

60. The optical amplifier apparatus according to claim
56, wherein said optical amplifier apparatus inputs a
20 wavelength-multiplexed signal light having mutually
different frequency components superimposed on optical
signals of three or more waves respectively, and said gain
inclination detecting unit detects frequency components
superimposed on the optical signals thereby to detect a gain
25 inclination.

61. An optical amplifier apparatus comprising:

an optical amplifier which amplifies an input wavelength-multiplexed signal light in an excitation light source;

5 a compensation light source which injects a compensation light that propagates in a forward direction of a propagation direction of the input signal light to said optical amplifier;

a first optical amplifier which amplifies the signal
10 light;

a second optical amplifier which amplifies an output signal light of said first optical amplifier;

a wavelength selecting unit which interrupts a compensation light at an output side of said second optical
15 amplifier, and transmits only a signal light;

an output detecting unit which detects an output level of a signal light at an output side of said wavelength selecting unit;

an output control unit which controls an output light
20 of said compensation light source according to an output level detected by said output detecting unit;

a gain inclination detecting unit which detects a gain inclination of said second optical amplifier; and

a gain inclination control unit which controls a gain
25 inclination by adjusting output lights of an excitation light

source of said first optical amplifier and an excitation light source of said second optical amplifier according to a gain inclination detected by said gain inclination detecting unit.

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62. The optical amplifier apparatus according to claim 61, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain inclination from optical signal levels of a shortest wave
10 and a longest wave.

63. The optical amplifier apparatus according to claim 61, wherein said gain inclination detecting unit branches a wavelength-multiplexed signal light, and detects a gain
15 inclination from optical signal levels of three or more waves.

64. The optical amplifier apparatus according to claim 61, wherein said optical amplifier apparatus inputs a
20 wavelength-multiplexed signal light having mutually different frequency components superimposed on optical signals of a shortest wave and a longest wave respectively, and said gain inclination detecting unit detects frequency components superimposed on the optical signals of respective
25 wavelengths thereby to detect a gain inclination.

65. The optical amplifier apparatus according to claim
61, wherein said optical amplifier apparatus inputs a
wavelength-multiplexed signal light having mutually
different frequency components superimposed on optical
5 signals of three or more waves respectively, and said gain
inclination detecting unit detects frequency components
superimposed on the optical signals thereby to detect a gain
inclination.